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PCB Source Control Investigation of the City of Tukwila Stormwater System

Jorgensen Pipe Discharge Area
City of Tukwila, WA

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1.0 INTRODUCTION

The City of Tukwila, WA (City) is located south of Seattle along the Green/Duwamish river corridor. The northern portion of the City borders the Lower Duwamish Waterway (LDW), which was listed by the Environmental Protection Agency (EPA) as a Superfund site in 2001 and as a Model Toxics Control Act site by Washington Department of Ecology (Ecology) in 2002. EPA is overseeing the remedial activity at the LDW and Ecology is in charge of source control. The goal of Ecology's source control investigations is to identify any potential ongoing sources of contamination prior to EPA initiating cleanup and remediation activities so that remediated sites are not recontaminated. The City of Tukwila has been part of a source control working group that was formed in 2002 to investigate potential sources of contamination up gradient in the Duwamish watershed.

In August of 2008, the City was contacted by Ecology regarding an ongoing source control investigation pertaining to PCB contamination in a portion of the LDW that was identified as one of 7 early action areas (EAA) within the LDW. This action area is known as EAA-4 or the Boeing Plant 2 /Jorgensen Forge area. Elevated levels of polychlorinated biphenyls (PCBs) had been detected on both the Boeing Plant 2 property and the adjoining Jorgensen Forge property. Particularly high PCB levels were identified in and around a concrete pipe, referred to as the Jorgensen pipe, which flows generally east to west between the two properties and discharges to the LDW.

While the high levels of PCBs in this pipe are likely attributable to historic contamination, Ecology is seeking verification that there are no ongoing, up-gradient sources of contamination. Much of the current watershed of the Jorgensen Pipe source control area falls within the city limits of Tukwila. City owned property includes about a half mile stretch of East Marginal Way. The remainder of the watershed is owned by King County International Airport (KCIA). PBS has prepared this report to specifically address the potential for the City owned storm drain system along East Marginal Way to be an ongoing source of PCB contamination in the Jorgensen Pipe.

In addition to the regulatory authority of EPA and Ecology, the City of Tukwila also has a responsibility to address potential contamination under City Code Titles 6 (Health and Sanitation), 14 (Water and Sewer), 21 (Environmental) and 22 (Solid Waste).

2.0 BACKGROUND

2.1 Polychlorinated biphenyls

Polychlorinated biphenyls (PCBs) are a class of organic compounds that were widely used in a number of applications during the interval from 1920 to 1977. They were most commonly used as an additive to coolants, lubricants, hydraulic fluids, cutting oils, flame retardants, adhesives, pesticides and fixatives. Their toxicity was first documented in the 1930's but it took another 40 years before their use was banned. They are widespread throughout the world in air, water, soil and sediments. PCBs are considered toxic to humans and wildlife, causing a variety of health effects. They have also been linked to cancer. PCBs are not easily degraded and can persist in the environment for long periods of time. They also tend to bioaccumulate up the food chain. Many different forms of PCB were developed with slightly differing molecular configurations. Some of the most common forms were marketed under the trade name of "Aroclor", with assigned numbers based on their chemical makeup. Testing for PCBs usually focuses on the most common of these Aroclors while more advanced testing looks at a wider list of known forms or congeners. The Washington State Sediment Quality Standard for PCBs is 12 mg/kg dry weight (dw) and the

Cleanup Screening Level is 65 mg/kg dw. For water samples, the acute exposure level is 2.0 *u*g/liter. The chronic exposure level is 0.014 *u*g/liter for freshwater and 0.03 *u*g/liter for saltwater.

2.2 Site Description

The Duwamish River flows north into Elliott Bay through the cities of Tukwila and Seattle. This river used to be at the end of a vast watershed that included the White, Green, Black and Cedar Rivers. During the late 1800s and early 1900s the river underwent dramatic changes, including the loss of about 70 percent of its former watershed area. The White River was diverted to the Puyallup River, the Cedar River was diverted to Lake Washington and the Black River dried up when the ship canal locks lowered the level of Lake Washington. Now the Green River is the only river that flows into the Duwamish and its flows are moderated by an upstream dam. Originally the Duwamish meandered through extensive tidal wetlands, but beginning in the early 1900s it was straightened and dredged to accommodate shipping and industry. Surrounding wetlands were filled and made available for development. By 1950 an industrial waterway had replaced the original river. The industries that located along this waterway included shipyards, marinas, aircraft manufacturers, timber mills, food processing plants, and many types of manufacturing. A myriad of wastes and pollutants ended up in the river and accumulated in the sediments.

The Boeing Plant 2 / Jorgensen Forge early action area is located between river miles 2.9 and 3.7 on the east bank of the Duwamish River. Conversion from wetlands and floodplain to crop lands occurred at this site as the Seattle area was settled during the late 1800s and early 1900s. The river was also straightened during this interval and shifted west from its original location at the current airport location. The site remained in cropland and wetlands until the mid 1930s when Boeing began developing Plant 2. The Isaacson Iron Works (now Jorgensen Forge) developed the site around 1940. Fill was placed on both properties to make them suitable for development and a 24” concrete pipe was installed on the Jorgensen property near the border between the two properties. This pipe is now referred to as the Jorgensen pipe. Apparently both Jorgensen Forge and Boeing Plant 2 discharged to this pipe at one time, but have since discontinued any discharge. The pipe now carries stormwater runoff from the City of Tukwila Stormwater System along East Marginal Way South and a portion of the King County International Airport (for details see Section 3.0)

Since most of this area was once tidal wetlands and floodplains, it is relatively flat and most of the developed surfaces have several feet or more of fill. As summarized in the Lower Duwamish Waterway Remedial Investigation (Windward Environmental, 2007) and the Boeing Uplands Corrective Measures Study for the south yard area (EPI/Golder,2007), groundwater is generally found 9 to 13 feet below the surface, at an elevation of 2 to 5 feet above sea level. General groundwater flow direction in the vicinity of the Jorgensen Pipe is south and west towards the Duwamish. During high tides, there can be groundwater flow from the river that extends inland from the river several hundred feet. An underlying aquifer in this region apparently extends 80 to 100 feet below the surface; creating potential movement of contaminants through the groundwater in a number of directions.

2.3 Investigations and Remedial Actions

In 1994, the Boeing Company entered into an Administrative Order on Consent with EPA regarding contamination at the Boeing Plant 2. PCBs were one of the identified contaminants at this site. Since then, Boeing has conducted and continues to carry out numerous characterizations and remedial actions at Plant 2. Also beginning around 1994, Jorgensen Forge initiated some voluntary clean-up activities with Ecology. In 2000, the City of Seattle, King County, the Port of Seattle, and the Boeing Company formed the Lower Duwamish Waterway Group to investigate contamination along the waterway. Under a voluntary agreement with EPA and Ecology, the group undertook a remedial investigation/feasibility study for the Lower Duwamish Waterway (Windward 2007). This investigation documented high levels of PCBs in a number of locations within the LDW.

Early Action Area 4, the Boeing Plant 2/Jorgensen Forge site, is one of the areas within the LDW that was identified as having particularly high levels of PCBs. Recorded PCB concentrations in surface sediments along this stretch of the River measured as high as 110 mg/kg dry weight(dw). PCB levels above the Washington State Sediment Cleanup Levels were found in sediments at 0-2, 2-4 and 6-8 ft depths near the outfall of the Jorgensen pipe. Studies are still on-going to identify the possible sources of this contamination. A transformer on the Boeing Plant 2 site just north of the Jorgensen Pipe was identified as one likely source of contamination. Grout in the pavement on portions of the Boeing Plant 2 site may have also contributed to the elevated levels in this area. Fill material used at the Jorgensen Forge site is also suspected of PCB contamination. Elevated PCB levels have been found not only in river sediment samples but also in soil and groundwater samples taken in the vicinity of the pipe. However, the highest concentration of PCBs have been found inside the Jorgensen Pipe with levels as high as 10,000 mg/kg dw. Table 1 shows PCB levels that have been recorded over the years in the Jorgensen pipe and in the King County Airport stormwater system that drains to the Jorgensen Pipe.

In July 2003 EPA and Jorgensen Forge entered into an Administrative Order of Consent to conduct an investigation into whether current or historical operations at the Jorgensen Forge site contributed to sediment contamination in the river. In 2006, EPA approved the investigation data summary report dated February, 2006 and requested that Jorgensen prepare an engineering cost analysis for cleanup of contaminated sediments. In 2007, Ecology and Jorgensen Forge signed an Agreed Order for a source control investigation. This work is currently on-going.

Boeing conducted follow-up investigations in the south yard portion of Plant 2, which is just north of the Jorgensen Pipe, the results of which were published in March of 2007 in the South Yard Area Data Gap Investigation Report. During initial investigation, PCB levels above the screening levels were found in about 1/5 of the groundwater samples taken in the vicinity of the Jorgensen Pipe. In the follow-up investigation, PCBs were not detected in any of the groundwater samples. Follow up soil samples showed PCB levels above the soil screening level of .033 mg/kg dw in several south yard areas, with the highest concentration (211mg/kg dw) in the transformer area.

Ecology issued a source control Strategy for the entire LDW in January of 2004. The City of Tukwila's role in this strategy included

> "*participating in developing those portions of Action Plans dealing with controlling sources of pollution discharging to the city-owned storm drain system when discharges from the city system may recontaminate sediment cleanup sites*."

Source control activities were scheduled to occur over the interval of 1/08 to 5/09. The source

control strategy takes a four tiered approach. This current effort is part of Tier 3, which consists of source control work in basins draining to the waterway sediments that were not identified for early or long-term cleanup actions.

Table 1. Levels of PCBs from Sediments Sampled in the Jorgensen Pipe and King County International Airport Storm System from Previous Investigations.

CB identifier	Location	Date Sample Taken Total PCB (mg/kg dry weight)						
		9/26/97	8/18/98	5/21/00	5/2/05	5/3/05	6/3/05	7/1/05
CB 4.005/ SD006	Jorgensen Pipe						**68**	
SD001	Jorgensen Pipe				**2,600**			
SD002	Jorgensen Pipe					**731**		
SD004	Jorgensen Pipe					**2,450**		
SD005	Jorgensen Pipe					**10,000**		
12SD-070105-01	Jorgensen Pipe							**1,100**
12SD-070105-02	Jorgensen Side Pipe							6.5
CB-565	KCIA		0.13	0.05				0.0 5
CB-579	KCIA		0.85	0.42				
CB-580	KCIA		0.60	0.97				
CB-584*	KCIA	**51**	**36**	**213**				
CB-6E	KCIA							0.19
CB-7E	KCIA							0.25
CB-9E	KCIA							0.14
Trench 2	KCIA							2.67

Data collected from several sources
Bold numbers exceed the State PCB sediment standard level of 12mg/kg dry weight
*CB 584 is likely subject to tidal flow
See Figure 3 for locations of catch basins

3.0 JORGENSEN PIPE SOURCE CONTROL AREA

The Jorgensen pipe is located at the south end of EAA-4 across the northern edge of the Jorgensen Forge property just south of the property line with Boeing Plant 2. Its outfall is at river mile 3.6. It is 24” in diameter and approximately 1,200 feet long from the manhole at the west edge of East Marginal Way to the outfall to the Duwamish. The elevation of the outfall of the pipe is approximately 9 feet above mean lower low water (MLLW) and the bottom of the manhole just west of East Marginal Way is 10.2 feet above MLLW. The slope of the pipe is less than 1 percent. Mean higher high water (MHHW) for the Seattle Area is 11.4 feet above MLLW (NOAA, 2008). Tidal influence therefore extends the full length of the pipe to East Marginal Way, actually extending at least part way across East Marginal Way in the concrete pipe that drains the airport area. Water

levels in the pipe rise and fall with the tides on a regular basis. The pipe is concrete except for the last 110 feet, which is corrugated metal. A large hole was found in the corrugated pipe approximately 60 feet from the outfall. A survey of the concrete pipe shows cracks and deterioration in some areas, particularly at the joints.

Stormwater runoff from both the Jorgensen Forge site and portions of the Boeing Plant 2 were likely directed to the Jorgensen pipe historically. Current maps show several feeder pipes from these properties that have been abandoned or sealed. The only current sources of stormwater to the pipe are the City stormwater system along East Marginal Way and discharge from the King County International Airport. This current drainage basin area includes approximately 26 acres of the King County International Airport and approximately 3 acres of East Marginal Way. Over 80 percent of the drainage area is impervious surface and includes airport runways, buildings and parking lots, East Marginal Way, sidewalks, and a portion of the railroad right of way.

One of the high priority source control action items identified in the 2007 to 2008 Ecology Source Control Report was to provide additional information pertaining to the drainage system along this portion of East Marginal Way "to determine if this portion of East Marginal Way South could be contributing to sediment recontamination in EAA-4". Another priority source control action item was to "determine ownership of the 12- and 24-inch diameter stormwater lines located along the Jorgensen/Boeing property line, and determine the exact locations of the connections between these lines and the stormwater systems of Jorgensen, Boeing, City of Tukwila, and KCIA." While the connections have mostly been verified through video surveys, ownership of the pipe appears to still be in question.

3.1 King County International Airport

The portion of the airport that drains to the Jorgensen pipe was at one time leased to Boeing. Stormwater and sediments in the airport stormwater system were evaluated in 1997, 1998, 2000 and 2005 as part of source control investigations undertaken by Boeing and King County. PCB levels were mostly below state sediment standards for PCB. The 2005 investigation also looked at joint compounds in the runway and did find elevated levels of Aroclor 1260 in some of the joint compound material, but this was still below the state standards. The only elevated levels of PCBs above the state standards were found in samples taken in 1997, 1998 and 2000 in CB-584 on the east side of East Marginal Way near the discharge to the Jorgensen pipe. This CB had high levels of Aroclor 1254, the same Aroclor found in high levels throughout the Jorgensen pipe. These elevated levels can likely be attributed to high tidal flows extending up to this catchbasin. King County recently issued a letter referencing these studies that concluded that the airport is not a current source of PCB contamination to the Jorgensen pipe. (KCIA, 2008)

3.2 City of Tukwila Stormwater System

After the river was straightened and moved and East Marginal Way was built, there was a small drainage at this location that drained to an embayment on the Jorgensen Forge site. When Isaacson Steel developed this site, the embayment and drainage were filled and the pipe installed. Storm water runoff from this section of East Marginal Way would simply sheet flow off the road onto the adjoining properties. As additional fill built up the areas on both sides of the road, stormwater from East Marginal Way had nowhere to go and began to collect in the street instead of running off. In 1996 the City installed a stormwater collection system along East Marginal Way to address flooding problems in the street. A total of 48 catchbasins were installed along both sides of East Marginal Way South to drain this area; 25 on the east side and 23 on the west side. The system

discharges into an existing stormwater line under East Marginal Way, which then discharges to the Jorgensen Pipe.

4.0 SOURCE CONTROL INVESTIGATION OF TUKWILA STORM SYSTEM

4.1 Sediment and Stormwater Sampling Methods

PBS collected grab samples of sediments and stormwater in representative catchbasins within the City owned stormwater system that drains to the Jorgensen pipe on October 2, 2008. Six catchbasins were chosen for sampling to represent each segment of the system. Samples were also collected from the manhole at the top of the Jorgensen Pipe. Sediment samples were collected using a stainless steel scoop attached to the end of an extendable PVC pole. The pole was lowered into an open catchbasin (CB) and the scoop was dragged along the bottom to collect sediment present in the CB. The pole was then extracted and the sediment pushed into a sterile 4 oz glass jar using nitrile gloves. The process was repeated until the 4 oz jar was filled with sediment. If water was also captured by the scoop, it was poured off the sediment back into the CB before the sediment was placed into the jar. One sample jar was filled at each catchbasin. To prevent cross contamination between samples, the scoop and lower end of the PVC pole were decontaminated using a TSP cleaning solution and a large aluminum bowl. A new pair of nitrile gloves was also used at each sampling location.

Water depth in the catch basin was measured in one of two ways, the first method was to lower a PVC pole into the water and then retract it and measure the area wetted by the water. The second method was to use a tape measure or Solinst Water Level Meter, Model 101 to determine the invert elevation of the water surface and then to measure the total depth of the sump and subtract the two numbers to get a water depth. Sediment depth was either measured with a tape measure or presented as a range that was approximated from visual or tactile observation because the material was often unevenly distributed in the catchbasin.

Water samples were collected using sterile, 500 mL amber colored glass bottles. The string was tied around the bottle neck and the bottle lowered to the water surface where it was dipped into the water and allowed to collect a sample. If the water level in the catchbasin was too low to accommodate a 500 mL bottle, a sterile, 4 oz glass jar was lower into the catchbasin to collect the sample. The sample was then poured from the glass jar into the amber colored glass bottle. Two 500 mL samples were collected at each catchbasin that contained water. Two of the seven catchbasins were dry during the site visit. All water and sediment samples were placed on ice and then transported to the NVL Laboratory in Redmond, WA where they were tested for PCB contamination using EPA method 8082. The TSP decontamination solution and all other used field materials were properly disposed of offsite.

4.2 Sampling Results

Seven sediment samples and five water samples were collected using the methods identified in Section 4.1 from six catchbasins along East Marginal Way and the Jorgensen Pipe manhole. The results from the PCB analysis at NVL are presented below in Table 2 and in Figure 4. Catchbasin reference numbers and locations can also be found on Figure 4.

Sediment samples from catchbasins 2679, 2716, 2615, and 2599 were non-detect for PCBs. Detection levels for the analysis were 0.2 mg/kg. Sediment from catchbasin 2672 contained 0.23 mg/kg dry weight PCB concentration. Sediment from catchbasin 2721 contained 0.91 mg/kg dry

weight total PCB concentration. Total PCB levels found in the Jorgenson Pipe CB measured 100 mg/kg dry weight. The Washington State Sediment Quality Standard for PCBs is 12 mg/kg dry weight and the Cleanup Screening Level is 65 mg/kg dry weight. Samples from catchbasins 2672 and 2721 both contain levels of PCB concentration below the Sediment Quality Standard. The sample from the Jorgensen Pipe location had concentrations ten times higher than the Sediment Quality Standard and above the Cleanup Screening Level. All detectable PCBs were Aroclor 1254.

Water samples from catchbasins 2679, 2716, 2615, and 2599 were non-detect for PCBs. Detection limits for this analysis were 0.1*u*g/liter. No water samples were obtained from catchbasins 2672 and 2721 because water was not present during the sampling period. The only elevated PCB concentrations were found in the water sample collected from the Jorgenson Pipe. The sample from this catchbasin had a PCB concentration of 22 *u*g/l. The acute exposure level is 2.0 *u*g/l. The chronic exposure level in freshwater is 0.014 *u*g/l and 0.03 *u*g/l in saltwater. Water collected from the Jorgensen Pipe exceeded both the acute and chronic exposure levels.

Table 2. Measured PCB Concentrations in Sediments and Stormwater Samples Obtained 10/02/08 from City of Tukwila Storm System in Vicinity of Jorgensen Pipe

CB Identifier	Location	Sediment Sample (mg/kg)	Water Sample (*u*g/L)
2615	North end, east side	ND	ND
2559	South end, east side	ND	ND
2672	North end, west side	0.23	n/a
2679	Middle, west side	ND	ND
2716	Middle, west side	ND	ND
2721	South end, west side	0.91	n/a
4.0005	Jorgensen Pipe CD west side of East Marginal Way, includes discharge from KCIA	**100***	**22***

ND – non-detect, below soil reporting limit of 0.2mg/kg
n/a – no water in catchbasin
^ Above State Sediment or Water Quality Standard
*Above State Cleanup Screening Level

5.0 DISCUSSION

The purpose of Ecology's source control investigation is to evaluate the potential for ongoing sources of contamination to recontaminate a site after clean up has occurred. Our sampling results, though limited, would appear to suggest that there are no significant current sources of PCB contamination entering City owned catch basins within the study area. Results from stormwater catch basin sampling throughout the LDW during earlier investigations found PCBs in 80% of the catchbasins with values ranging from 0.016 to 2,226 mg/kg dry weight (dw). However only 12% of the samples exceeded the Sediment Quality Standard and only 6% exceeded the Cleanup Screening Level. Eighty one percent were less than 1 mg/kg dw (Cargill 2008). PCB levels recorded from sediment samples collected in the catch basins during this study appear to be consistent with

these previous results. The two CBs where PCBs were found above the detection limit were both on the west side of East Marginal Way bordering the Boeing Plant 2 property. Both were also CBs that had no stormwater, which could simply indicate that they are flushed less frequently. Since PCB contaminated particles can become airborne as dust, it is possible to find low levels of PCB far from any immediate source. PCB levels in the City owned catch basins along East Marginal Way were also consistent with those measured on the KCIA except that only Aroclor 1254 was found in the City system and both Aroclor 1254 and Aroclor 1260 were found at the airport. The Aroclor 1260 appears to be associated with grout used at the airport.

The elevated PCB levels we found in the manhole at the top of the Jorgensen Pipe were consistent with previous measurements at this location and with measurements taken at the KCIA intertie on the opposite side of East Marginal Way. Our sample measured 100 mg/kg, whereas a sample taken in 2005 at the same location had 68 mg/kg. Levels recorded across the street at the King County outfall were 36, 51 and 128 mg/kg dw. During the 2005 sampling effort in the Jorgensen pipe, the recorded level in the manhole at the top of the pipe(68 mg/kg dw) was the lowest level recorded in the pipe. PCB levels further down gradient in the Jorgensen Pipe ranged from 731 to 10,000 mg/kg dw. with the highest level (10,000 mg/kg dw) recorded near the transformer site on Boeing Phase 2 property.

With no identifiable source of PCB contamination entering the pipe from either the City system or the King County airport system, it appears that the major sources of contamination in the pipe are attributable to historic contamination located further down the pipe and in the Duwamish Waterway. Previous studies support this assumption. If stormwater were the only source of water in the pipe, and the stormwater was not an ongoing source of PCB contamination, one would assume a gradual reduction in PCB contamination levels at the top of the pipe over time as contaminated sediments were gradually washed down the pipe. The fact that this has not occurred indicates that the stormwater is either of insufficient quantity to transport sediments or that contamination is continually moving up the pipe to the extent that it offsets any flushing effect of the stormwater. The current drainage area is relatively small and stormwater runoff is not likely to produce either the volume or velocity necessary to effectively scour out existing sediments. Tidal flows regularly flow up the pipe to East Marginal Way and appear to account for a much higher percentage of flow in the pipe than stormwater discharge. Even if all stormwater discharge were to be discontinued, there would be a continuous flushing of contamination back and forth throughout the length of the pipe. PCBs do not readily degrade and can persist in the sediments in the pipe for many years. Because of the low pipe gradient, water often sits for long periods, especially during tidal swings. Elevated levels of PCBs have been recorded in numerous locations within the river channel, in soils proximate to the river and in soil and groundwater samples in the vicinity of the pipe. Cracks in the pipe and poorly sealed feeder pipes can allow groundwater and sediments to seep into the pipe and come in contact with tidal flow. Tidal flows in the Duwamish can also bring contaminated sediments and/or contaminated water back into the pipe from the Duwamish.

In conclusion, it appears highly unlikely that the City of Tukwila stormwater system that drains to the Jorgensen Pipe is either an ongoing source of PCB contamination or contributing significantly to the flushing of PCB contaminated water or sediments out into the Duwamish Waterway.

6.0 REFERENCES

AES. April 5, 2007. Lower Duwamish Water Way Early Action Area 4 Seattle/Tukwila, WA. Jorgensen Forge Facility-Being Plant 2 Facility: Property Line Stormwater Lines, Figure 20. Ecology and Environment, Inc., Seattle, Washington.

Anchor Environmental. 2008. Figure 5-2. SIA Plan Showing Total PCBs in Soil

Boeing Plant 2 Upland Source Control Storm Drain Investigation Video 1.

Cargill, Dan. and SAIC. May 2008. Lower Duwamish Waterway Source Control Status Report July 2007 to March 2008. Publication # 08-09-063. Washington State Department of Ecology,Toxics Cleanup Program, NW Regional Office, Bellevue, WA.

CH2MHill. July 2003. Guidance for Sampling of Catch Basin Solids. Standard Operating Procedures. Prepared for City of Portland, Oregon.

City of Tukwila Public Works Department. 2006. East Marginal Way Plan and Profile STA. 108+00 to STA. 114+00, STA. 114+00 to STA. 120+00 and STA. 120+00 to 126+00. City of Tukwila, Tukwila, Washington.

ENSR / AECOM. October 2007. Lower Duwamish Waterway Sediment Transport Analysis Report. Included in the Lower Duwamish Waterway Remedial Investigation 11/07.

Environmental Partners, Inc. and Golder Associates, Inc. March 2007. Uplands Corrective Measures Study Volume IIIb: South Yard Area, Data gap investigation report. Boeing Plant 2 Seattle/Tukwila, WA http://yosemite.epa.gov/R10/CLEANUP.NSF/LDW/Boeing+Plant+2

GeoMatrix. April 2008. Horizontal Boundary Technical Memorandum. Boeing Plant 2 Duwamish Sediment Other Area, SeattleTukwila, Washington.

Golder Associates Inc. May 2008. 2008 Stormwater Source Control Interim Measure Work Plan for Boeing Plant 2 Seattle/Tukwila, Washington. Golder Associates Inc., Redmond, Washington.

Golder Associates Inc. June 2006. Draft figure: South Yard Area (East) Total PCBs in Soil

Hendrickson, Kristy. May 25, 2005. Letter to Carl Bach of The Boeing Company, Regarding: Catch Basin Sampling at North Boeing Field. Landau Associates, Edmonds, Washington.

Huey, Richard. Jaunary 2004. Lower Duwamish Waterway Source Control Strategy. Washington State Department of Ecology Toxics Cleanup Program, Bellevue, WA. Publication No. 04-09-043.

Ith, Ian. 2004. The Road Back – From Seattle's Superfund Sewer to Haven Once More. http://seattletimes.nwsource.com/pacificnw/2004/1003/cover.html Accessed October 2008.

King County Airport/ East Marginal Way South MH-1-E Video Inspection

Oregon Dept. of Environmental Quality. May 2008. Appendix A: Instructions for Developing a Stormwater Assessment Workplan. Guidance for Evaluating the Stormwater Pathway at Cleanup Sites DEQ 08-LQ-076. on the web at: http://www.deq.state.or.us/lq/pubs/docs/cu/stormwater/GuidanceSWAppendixA.pdf Accessed September 2008.

Rayner, V. April 16, 2007. Lower Duwamish Water Way Early Action Area 4 Seattle/Tukwila, WA. King County International Airport Stormwater Drainage Basin 5 – South End, Figures 25 and 26. Ecology and Environment, Inc., Seattle, Washington.

Renaud, Rick. May 8, 2008. Letter to John Keeling of the Washington State Department of Ecology, Regarding: Early Action Area 4: Boeing Plant 2/Jorgensen Forge Property Line Stormwater Lines. Department of Transportation, Seattle, Washington.

Richards, Mark. January 2008. Sampling and Analytical Protocols for Monitoring PCBs in Effluent and Storm Water. Presentation by VA Dept. of Environmental Quality.

Shay, Steve. December 12, 2007. Duwamish formidable clean-up Job. http://www.westseattleherald.com/articles/2007/12/12/news/local_news/news01.txt Accessed October 2008.

U.S. Environmental Protection Agency, Region 10. September 2004. Environmental Fact Sheet: Boeing Plant 2. EPA, Seattle, Washington.

U.S. Environmental Protection Agency, Region 10. August 2007. Lower Duwamish Site. http://yosemite.epa.gov/r10/nplpad.nsf/2fde3874b2354093882568db0068885d/505bc87c0b771b9d882569b4006a2ee3!OpenDocument Accessed October 2008.

U.S. Environmental Protection Agency. September 2001. Boeing Plant 2 Environmental Fact Sheet. http://yosemite.epa.gov/R10/CLEANUP.NSF/ddea47a33877982f88256db8007e8049/c239aaaf64b4d57b88256e37000775c0/$FILE/LDfsboeing2.pdf

U.S. Environmental Protection Agency. June 2003. Administrative Order on Consent for Sampling and Analysis at Jorgensen Forge Property, US EPA Docket No CERCLA 10-2003-0111. http://yosemite.epa.gov/r10/cleanup.nsf/sites/Jorgensen/

U.S. Environmental Protection Agency. June 2006. Jorgensen Forge Facility. Administrative Order on Consent, US EPA Docket No CERCLA 10-2003-0111. Approval for Final Investigation Data Summary Report and Request for an Engineering Evaluation/Cost Analsis. http://ypsemite.epa.gov/r10/cleanup.nsf/sites/Jorgensen/$FILE/SOW-Jorgensen.pdf

Washington Administrative Code. WAC 173-201A-240 Toxic Substances WAC 173-204-320 Sediment Quality Standards and WAC 173-204-520 Cleanup Screening Levels.

Washington State Department of Ecology. Jorgensen Forge. http://www.ecy.wa.gov/programs/tcp/sites/jorensen/forge_hp.htm Accessed October 2008.

Washington State Department of Ecology. Lower Duwamish Waterway Source Control Investigation. http://www.ecy.wa.gov/programs/tcp/sites/lower_duwamish/sites/early_action_area_4/early Accessed October 2008.

Washington State Department of Ecology. April 2007. Jorgensen Forge Site, Ecology negotiates agreed order. Ecology publication #07-09-061, Bellevue, Washington. http://www.ecy.wa.gov/programs/tcp/sites/jorgensen/forge_hp.htm

Washington State Department of Ecology. May 2007. Site study would prepare for Duwamish cleanup project. News release 07-110. http://www.ecy.wa.gov/news/2007/news/2007-110.html

Washington State Department of Ecology. June 2007. Lower Duwamish Waterway Early Action Area 4 Final summary of Existing Information and Identification of Data Gaps Report. Work assignment #EANE001, Toxics Cleanup Program, Bellevue, Washington.

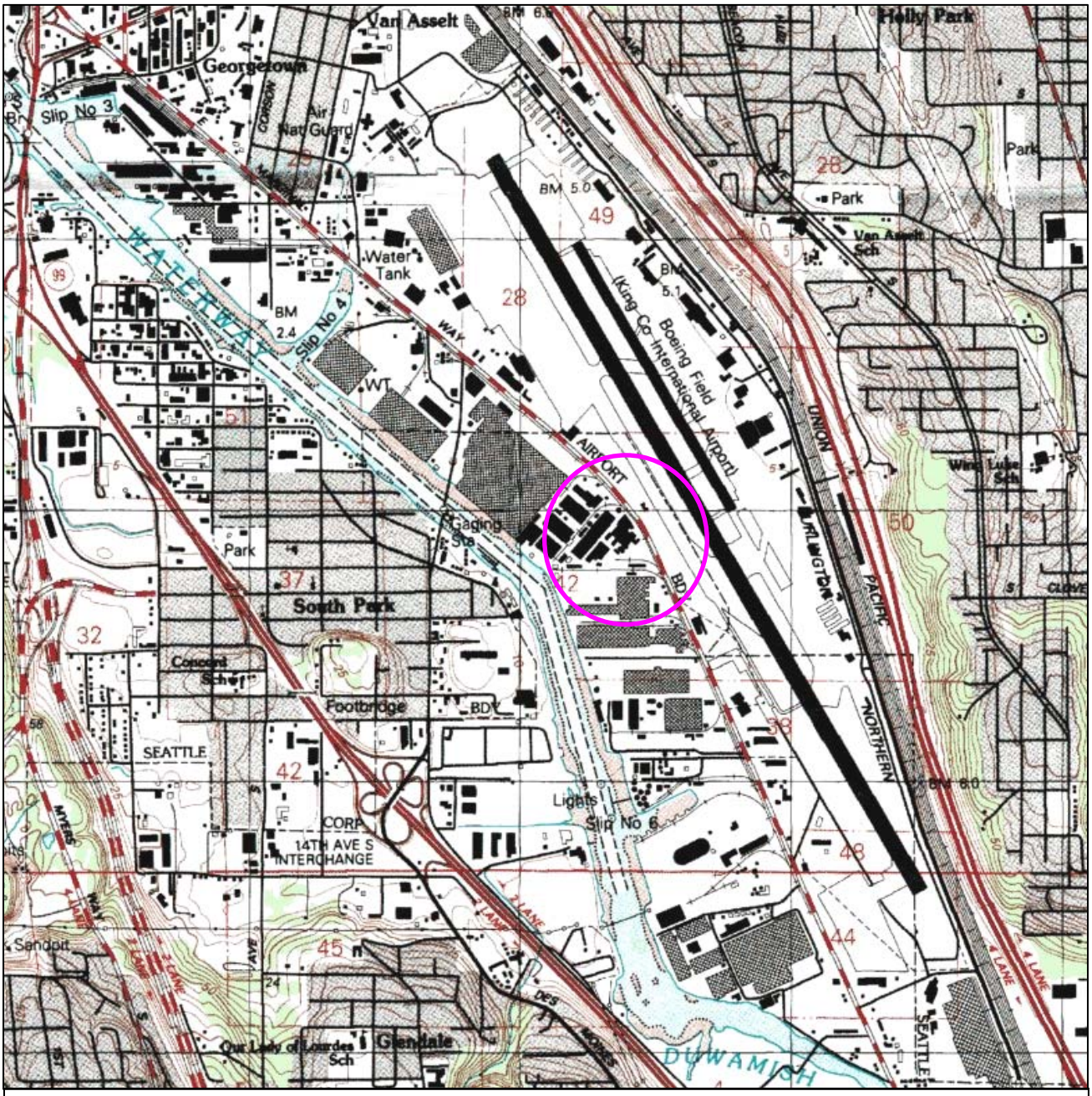
Washington State Department of Ecology. July 2007. Agreed Order: in the matter of remedial action by: Jorgensen Forge Corporation. No. DE 4127.

Washington State Department of Ecology. Summer 2007. Lower Duwamish Waterway Source Control Update. Ecology publication #07-09-065, Olympia, Washington.

Wind Ward Environmental. November 2007. Lower Duwamish Waterway Remedial Investigation http://yosemite.epa.gov/r10/CLEANUP.NSF/LDW/Lower+Duwamish+Waterway+Draft+Phase+II+Remedial+Investigation+Report/

FIGURES

Figure 1: Vicinity Map



USGS Quadrangle: Seattle South, 1983

Figure 2: Early Action Area 4, Boeing Plant 2 / Jorgensen Forge

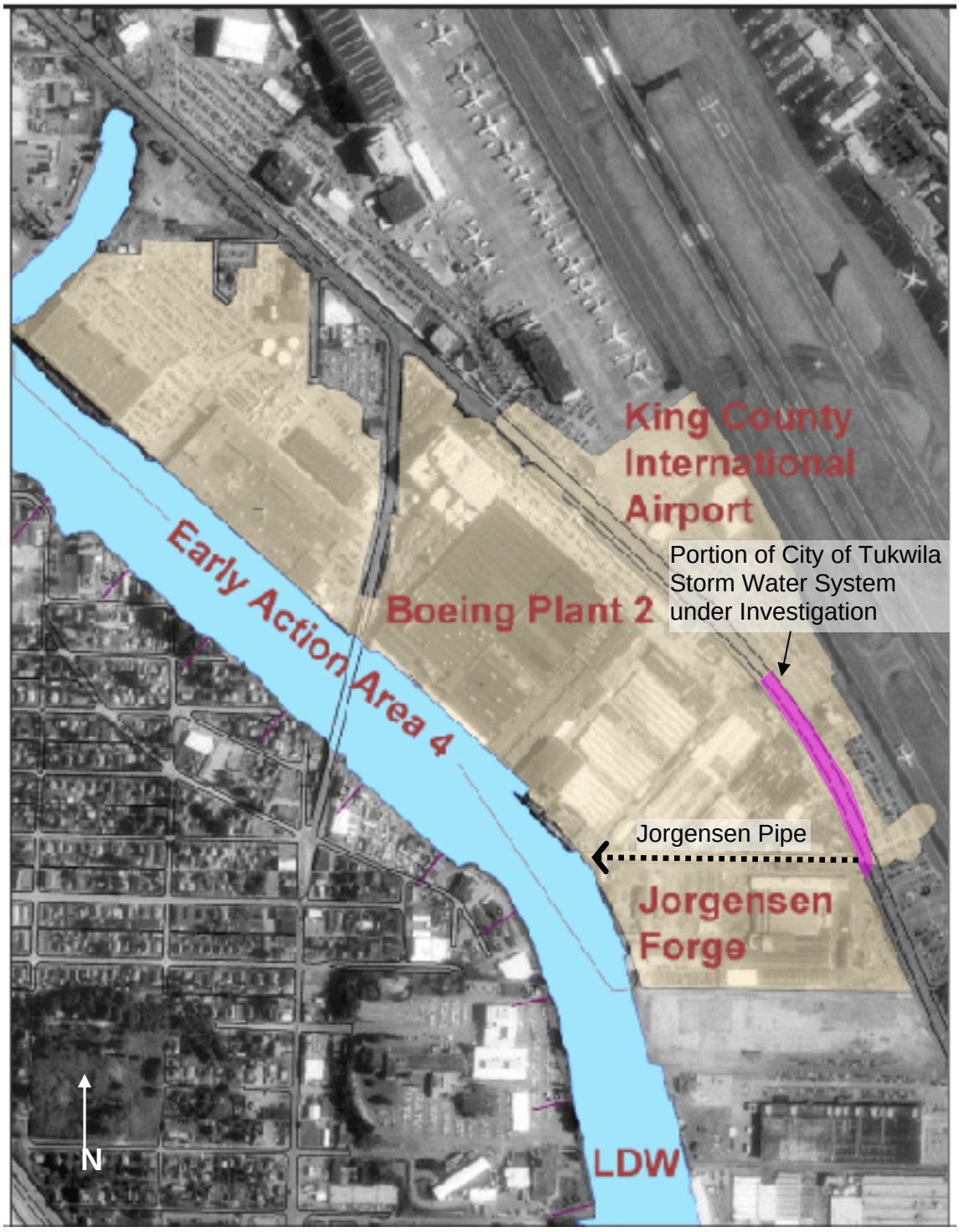


Figure adapted from: WA Department of Ecology, Lower Duwamish Waterway Source Control Investigation, EAA-4
http://www.ecy.wa.gov/programs/tcp/sites/lower_duwamish/sites/early_action_area4/early_action_area_4.htm

Figure 3: Previous PCB Sampling Locations and Results

CB identifier	Location	Date Sample Taken Total PCB (mg/kg dry weight)						
		9/26/97	8/18/98	5/21/00	5/2/05	5/3/05	6/3/05	7/1/05
CB 4.005/ SD006	Jorgensen Pipe						**68**	
SD001	Jorgensen Pipe				**2,600**			
SD002	Jorgensen Pipe					**731**		
SD004	Jorgensen Pipe					**2,450**		
SD005	Jorgensen Pipe					**10,000**		
12SD-070105-01	Jorgensen Pipe							1,100
12SD-070105-02	Jorgensen Side Pipe							6.5
CB-565	KCIA		0.13	0.05				0.0 5
CB-579	KCIA		0.85	0.42				
CB-580	KCIA		0.60	0.97				
CB-584	KCIA	**51**	**36**	**213**				
CB-6E	KCIA							0.19
CB-7E	KCIA							0.25
CB-9E	KCIA							0.14
Trench 2	KCIA							2.67

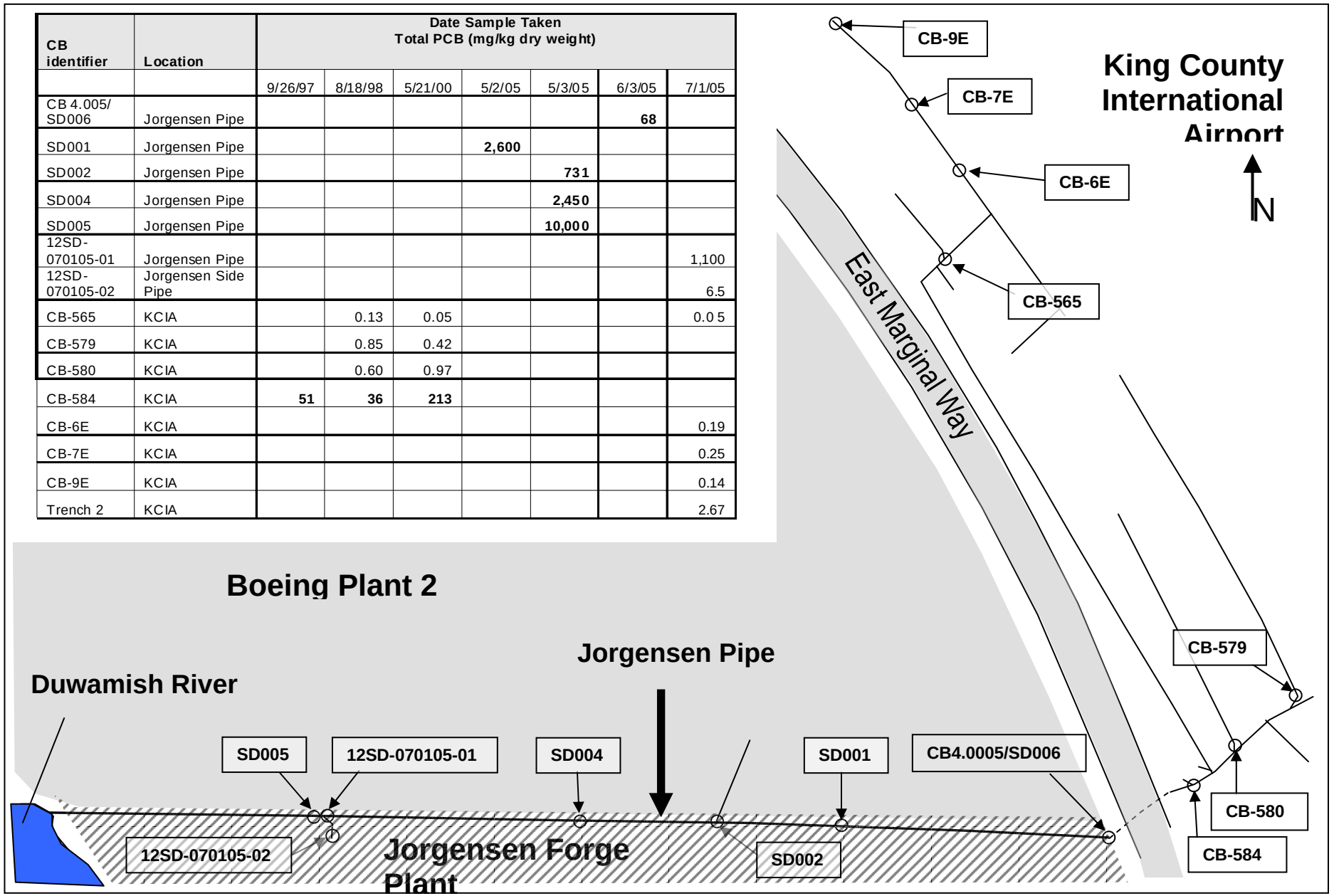
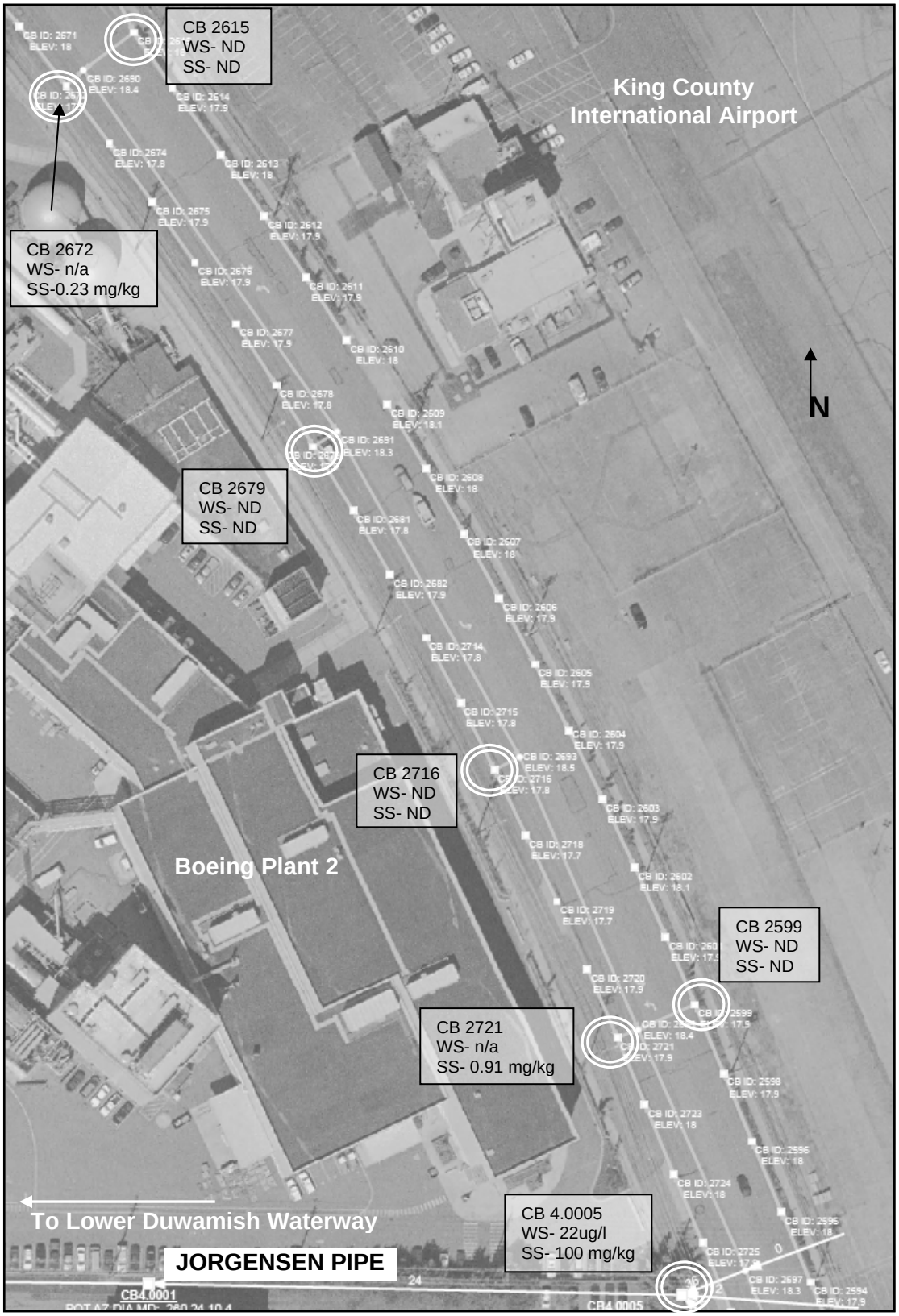


Figure 4. Sampling locations and results



WS: water sample, SS: sediment sample (dry weight), ND: non-detect, n/a: no sample collected
Image provided by City of Tukwila Public Works

APPENDIX A

Laboratory Results

Advanced Analytical Laboratory
(425) 497-0110, fax (425) 497-8089

AAL Job Number: A81002-2
Client: PBS Environmental
Project Manager: Harry Goren
Client Project Name: Tukwila PCB Sampling
Client Project Number: 40407.11
Date received: 10/02/08

Analytical Results

8082(PCBs), mg/kg		MTH BLK	LCS	2672-S	2721-S	2679-S	2716-S
Matrix	Soil	Soil	Soil	Soil	Soil	Soil	Soil
Date extracted	Reporting	10/03/08	10/03/08	10/03/08	10/03/08	10/03/08	10/03/08
Date analyzed	Limits	10/03/08	10/03/08	10/03/08	10/03/08	10/03/08	10/03/08
A1221	0.20	nd		nd	nd	nd	nd
A1232	0.20	nd		nd	nd	nd	nd
A1242 (A1016)	0.20	nd		nd	nd	nd	nd
A1248	0.20	nd		nd	nd	nd	nd
A1254	0.20	nd	86%	0.23	0.91	nd	nd
A1260	0.20	nd		nd	nd	nd	nd
Surrogate recoveries:							
Tetrachloro-m-xylene		103%	98%	103%	85%	99%	98%
Decachlorobiphenyl		89%	82%	77%	75%	73%	81%

Data Qualifiers and Analytical Comments
nd - not detected at listed reporting limits
na - not analyzed
C - coelution with sample peaks
M - matrix interference
J - estimated value
Results reported on dry-weight basis
Acceptable Recovery limits: 70% TO 130%
Acceptable RPD limit: 30%

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Date received: 10/02/08

Analytical Results

8082(PCBs), mg/kg		2615-S	2599-S	CB 4.005-S	2672-S MS	2672-S MSD	2672-S RPD
Matrix	Soil	Soil	Soil	Soil	Soil	Soil	Soil
Date extracted	Reporting	10/03/08	10/03/08	10/03/08	10/03/08	10/03/08	10/03/08
Date analyzed	Limits	10/03/08	10/03/08	10/03/08	10/03/08	10/03/08	10/03/08
A1221	0.20	nd	nd	nd			
A1232	0.20	nd	nd	nd			
A1242 (A1016)	0.20	nd	nd	nd			
A1248	0.20	nd	nd	nd			
A1254	0.20	nd	nd	100	81%	77%	5%
A1260	0.20	nd	nd	nd			
Surrogate recoveries:							
Tetrachloro-m-xylene		96%	101%	93%	90%	96%	
Decachlorobiphenyl		81%	81%	84%	79%	78%	

Data Qualifiers and Analytical Comments
nd - not detected at listed reporting limits
na - not analyzed
C - coelution with sample peaks
M - matrix interference
J - estimated value
Results reported on dry-weight basis
Acceptable Recovery limits: 70% TO 130%
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AAL Job Number: A81002-2
Client: PBS Environmental
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Client Project Number: 40407.11
Date received: 10/02/08

Analytical Results

8082(PCBs), µg/l		MTH BLK	LCS	2679-W	2716-W	2615-W	2599-W	CB 4.005-W
Matrix	Water	Water	Water	Water	Water	Water	Water	Water
Date extracted	Reporting	10/03/08	10/03/08	10/03/08	10/03/08	10/03/08	10/03/08	10/03/08
Date analyzed	Limits	10/03/08	10/03/08	10/03/08	10/03/08	10/03/08	10/03/08	10/03/08
A1221	0.1*	nd		nd	nd	nd	nd	nd
A1232	0.1*	nd		nd	nd	nd	nd	nd
A1242 (A1016)	0.1*	nd		nd	nd	nd	nd	nd
A1248	0.1*	nd		nd	nd	nd	nd	nd
A1254	0.1*	nd	86%	nd	nd	nd	nd	22
A1260	0.1*	nd		nd	nd	nd	nd	nd
Surrogate recoveries:								
Tetrachloro-m-xylene		118%	98%	107%	114%	111%	109%	110%
Decachlorobiphenyl		97%	82%	95%	92%	90%	95%	88%

*- instrument detection limits

Data Qualifiers and Analytical Comments
nd - not detected at listed reporting limits
na - not analyzed
C - coelution with sample peaks
M - matrix interference
J - estimated value
Acceptable Recovery limits: 70% TO 130%
Acceptable RPD limit: 30%

APPENDIX B

Field Data Sheet

PCB Source Control Investigation of City of Tukwila Stormwater Collection System that Discharges to Jorgensen Pipe

Date:	10/2/1008	Staff:	KML, HG, TBM			Weather:	Light rain	
CB ID	Station	GE (ft)	IE (ft)	CB depth (ft)	Actual depth (ft)	Depth of Water (in)	Depth of Sediment (in)	Comments
2672	124+50 (W)	14.39	11.67	2.72	3.5	N/A	Uneven, 0-1	Pipe coming in from the west under Boeing property. Sediment dry, primarily sandy.
2615	124+50 (E)	14.54	10.1	4.44	5.9	16	Uneven, 1-2	Not much sediment, sandy sediment, a lot of organic matter
2679	(W)	14.48	10.86	3.62	3.8	3		Sandy sediment, some organic matter, slight petroleum sheen
2716	~119 (W)	14.41	11.19	3.22	3.6	1.5		Sandy
2721	~117 (W)	14.5	11.28	3.22	3.5	N/A	Uneven, 0-0.5	Sediment sandy, some organic matter
2599	~117 (E)	14.48	10.17	4.31	5.8	13	1.5 approx.	Sandy sediment with leafy organic matter
CB4.0005	115+50	14.85	4.08	10.77	9.1	0.6		Very little organic matter

APPENDIX C

Photos

Photo 1. View south along East Marginal Way at south end of study area

Photo 2. View north along East Marginal way with King County International Airport along right side

Photo 3. Inside of typical City of Tukwila catch basin in study area

Photo 4. PBS team sampling for sediments and storm water in City catch basin

Photo 5. Manhole at top of Jorgensen Pipe along west side of East marginal Way

Photo 6. Inside of manhole at top of Jorgensen Forge pipe